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(54) **Electrostatic probe device for signal detection of cathode ray tube displays**

(57) An electrostatic probe device detects signals displayed on a cathode ray tube in a non-invasive manner. Specifically, the probe device includes a probe that is spaced from a fluorescent screen of a cathode ray tube by a dielectric material and a detection circuit coupled to probe. The detection circuit produces an output signal that corresponds to an input video signal supplied to the cathode ray tube. In a preferred embodiment, the probe is located directly on a face plate of the cathode ray tube, wherein the face plate acts as the dielectric material. Voltage fluctuations detected by the probe are equalized by the detection circuit. The detection circuit may also include amplification and inverter circuits, so that the output of the detection circuit can be supplied to a monitor for viewing. The image displayed on the monitor directly corresponds to the image displayed on the cathode ray tube.

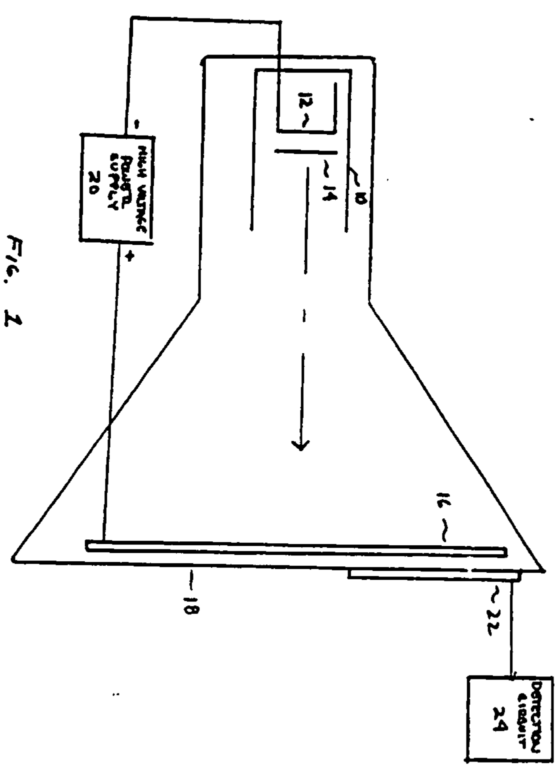

FIG. 1

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Description

Field of the Invention

The invention relates in general to devices for detecting signals displayed on cathode ray tubes. More specifically, the invention relates to an electrostatic probe device that can detect signals displayed on cathode ray tubes in a non-invasive manner.

Background of the Invention

The expansion of subscription television services, such as cable television and direct broadcast satellite services, and conventional broadcast television has driven the need for a device that is capable of monitoring the signals displayed on television sets in a non-invasive manner. In the case of broadcast television services, it is desirable to develop a device that can monitor the image displayed on a television to determine which program is being viewed at any given time in order to establish advertising ratings. In the case of subscription services, in addition to establishing advertising ratings, it is further desirable to monitor the television display to insure that unauthorized channels or pay-per-view programs are not being viewed. In either case, it is preferable that the monitoring device be non-invasive, namely, that it unobtrusively and automatically detect the signals displayed on cathode ray tube of the television without requiring action on the part of the viewer.

In view of the above, it is an object of the invention to provide a probe that can detect the signals displayed on a cathode ray tube. It is a further object of the invention to provide a probe that is non-invasive.

Summary of the Invention

The invention provides an electrostatic probe device that is capable of detecting signals displayed on a cathode ray tube in a non-invasive manner. Specifically, the probe device includes a probe that is spaced from an effective anode structure, for example a fluorescent screen, shadow mask or similar structure, of a cathode ray tube by a dielectric material and a detection circuit coupled to probe. The detection circuit produces an output signal that corresponds to an input video signal supplied to the cathode ray tube. In a preferred embodiment, the probe is located directly on a face plate of the cathode ray tube, wherein the face plate acts as the dielectric material. Voltage fluctuations detected by the probe are equalized by the detection circuit. The detection circuit may also include amplification and inverter circuits, so that the output of the detection circuit can be supplied to a monitor for viewing. The image displayed on the monitor directly corresponds to the image displayed on the cathode ray tube. Thus, the output from the probe can be used to detect the images displayed on the cathode ray tube as well as on screen displays or similar features that might be selected by a user.

Description of the Drawings

The invention will be described with reference to certain preferred embodiments and the accompanying drawings, wherein:

Fig. 1 is a basic schematic diagram of a cathode ray tube;
Fig. 2 is a schematic diagram illustrating a preferred detection circuit;
Fig. 3 illustrates an input video signal applied to the cathode ray tube illustrated in Fig. 1;
Fig. 4 illustrates the signal detected by the probe illustrated in Fig. 1;
Fig. 5 illustrates the output signal from the detection circuit illustrated in Fig. 2;
Fig. 6 illustrates the output of the detector circuit illustrated in Fig. 7; and
Fig. 7 illustrates an experimental set-up used to detect the signal supplied to a cathode ray tube and reproduce the signal on a separate monitor.

Detailed Description of the Preferred Embodiments

A basic schematic diagram of a cathode ray tube (CRT) is illustrated in Fig. 1. The CRT includes an electron gun 10, having a cathode 12 and a control grid 14, and an effective anode structure 16, for example a fluorescent screen, shadow mask or similar structure located adjacent to a glass face plate 18. The cathode 12 and the anode structure 16 are coupled to a high voltage power supply 20. In operation, electrons are emitted from the cathode 12 and are focused as an electron beam onto the anode structure 16. The position of the electron beam is varied by either internal electrostatic deflection plates or external electromagnetic deflection coils (not shown) to produce a trace on the anode structure 16 in a conventional manner.

The high voltage power supply 20 is least loaded when the CRT is dark and no current is flowing to excite the phosphors in the anode structure 16. The high voltage produced by the high voltage power supply 20 is therefore altered to some extent as a function of the beam current. Specifically, as the high voltage power supply 20 has some practical internal resistance or source impedance, the voltage rises (CRT dark) or falls (screen phosphors excited) as the beam current fluctuates, namely, the instantaneous voltage tends to follow the reverse of the brightness of the trace displayed on the CRT. In the case of a color CRT, the same fluctuation is present for each of the colored phosphors and their corresponding electron gun structures. The variation in voltage, in a typical large screen receiver, is on the order of a few hundred volts imposed upon some 20 KV of anode potential, which is on the order of a few percent when described instantaneously. The present invention

is based on the recognition that the fluctuations in the voltage are directly related to the image displayed on the CRT, and can therefore be utilized to detect the information content of the displayed image.

In order to detect the supply voltage variation, a capacitively coupled probe 22 is placed on the face plate 18 of the CRT in a preferred embodiment of the invention as illustrated in Fig. 1, thereby effectively placing the probe 22 within a fraction of an inch of the anode structure 16. The probe 22 can be located on any portion of the face plate 18 that is located in front of the anode structure, although it is preferably to locate the probe 22 along one of the side edges of the face plate 18 in order to prevent interference with the normal viewing area of the CRT. Variations in the supply voltage detected by the probe 22 are coupled to a detection circuit 24 via a virtual capacitor formed from a first plate consisting of the anode structure, a dielectric material consisting of the glass of the face plate 18, and a second plate formed by the probe 22. The detection circuit 24 provides an equalized output signal that directly corresponds to a video input signal used to modulate the beam current and produce an image on the CRT. Thus, the output of the detection circuit 24 can be used to identify the signal displayed on the CRT.

Fig. 2, for example, illustrates a detection circuit 24 utilized in experiments conducted to verify the operational characteristics of the probe 22. In the illustrated example, a ten inch piece of wire taped on the face plate of the CRT was utilized as the probe 22. The probe 22 was therefore effectively within about 0.25 inches of the phosphors in the fluorescent screen of the CRT. The probe 22 was coupled to a detection circuit 24 including an equalization circuit 25 formed from a resistor-inductor-capacitor network as illustrated. An input video signal, as illustrated in Fig. 3, was then applied to the CRT. Fluctuations in the supply voltage were picked up by the probe 22 as shown in Fig. 4 and supplied to the detection circuit 24, which generated the output signal illustrated in Fig. 5. As can be seen, the output of the detector circuit 24 shown in Fig. 5 corresponds to the input video signal illustrated in Fig. 3.

The correspondence between the output of the detector circuit 24 can be further demonstrated by incorporating an amplification circuit 26 and inverter circuit 28 into the detector circuit 24 and supplying the resulting output signal illustrated in Fig. 6 to a separate monitor 30 as illustrated in Fig. 7. The monitor 30 is synchronized to the input video signal supplied to the CRT using an external synchronization pulse, which results in a display on the monitor 30 that duplicates the display on the CRT being detected by the probe 22.

It will be understood by those of ordinary skill in the art that it is not necessary to actually reproduce the image displayed on the CRT on a separate monitor for purposes of detecting the program being viewed on the CRT. Instead, signal analysis circuitry (either digital or analog) may be utilized to analyze and compare the signal(s) generated by the detection circuit (e.g. Probe) to the video that represents each of the channels of potential selection made available to a device such as a television receiver thereby identifying the channel to which the receiver is actually tuned.

The invention is also not limited to the application of program detection. The probe can be utilized to permit accurate adjustment of several operation parameters of a television receiver during manufacture. For example, the probe can be utilized at the time of final alignment of the television receivers by the manufacturer. Specifically the brightness and contrast of the display can be adjusted so as to be free of white or black compression. In addition, analysis of the information present on relevant scanning lines, namely those early and late in the field and at the beginning and end points of a scanning line, permits a method of precise alignment of the scanning fields developed by the yoke relative to the surface area of the screen.

The signal recovered by the probe is rich in harmonic energy, as the overall behavior of the CRT, the internal resistance of the power supply, and the virtual capacitor created by the elements discussed above all tend to behave as a single-ended Class C resistance-coupled triode. Additionally, significant energy from the chroma portion of a color signal can be recovered both at its fundamental frequency (3.58 MHz for NTSC) and at least its second harmonic (7.16MHz). These signals can be evaluated in such a way to render information as to the chromatic activity of the receiver.

The invention has been described with reference to certain preferred embodiments thereof. It will be understood, however, that modifications and variations are possible within the scope of the appended claims. For example, the probe may be implemented as a separate device that is attached to the face plate of CRTs as was done in the illustrated embodiment or may be incorporated during the manufacture of a CRT as an integral component. Still further, it is noted that when the probe is operated in a location where strong fields are present from radio sources that operate in the spectrum utilized by the video display 9 (e.g. a few kilohertz to 4.2 MHz), the probe will also respond to these fields. The ambient field can be received by locating a second probe similar in electrical properties to the main probe in an area near the main probe but not in material coupling to the CRT. The signal from the second probe can be inverted and applied to the signal received by the main probe to provide a significant degree of cancellation, thereby allowing the system to be essentially immune to the external field.

Claims

1. An apparatus for detecting signals displayed on a cathode ray tube, said apparatus comprising:
   a probe spaced from an anode structure of the

cathode ray tube by a dielectric material: and a detection circuit coupled to probe: wherein the detection circuit produces an output signal that corresponds to an input video signal supplied to the cathode ray tube.

2. An apparatus as claimed in claim 1, wherein the probe is located on a face plate of the cathode ray tube.

3. An apparatus as claimed in claim 2, wherein the dielectric material comprises the face plate of the cathode ray tube.

4. An apparatus as claimed in claim 1, wherein the detection circuit comprises an equalization network.

5. An apparatus as claimed in claim 1, wherein the detection circuit further comprises an amplification circuit coupled to the equalization network.

6. An apparatus as claimed in claim 5, wherein the detection circuit further comprises an inverter circuit coupled to the amplification circuit.

7. An apparatus as claimed in claim 1, wherein the anode structure comprises a fluorescent screen.

8. An apparatus as claimed in claim 1, wherein the anode structure comprises a shadow mask.

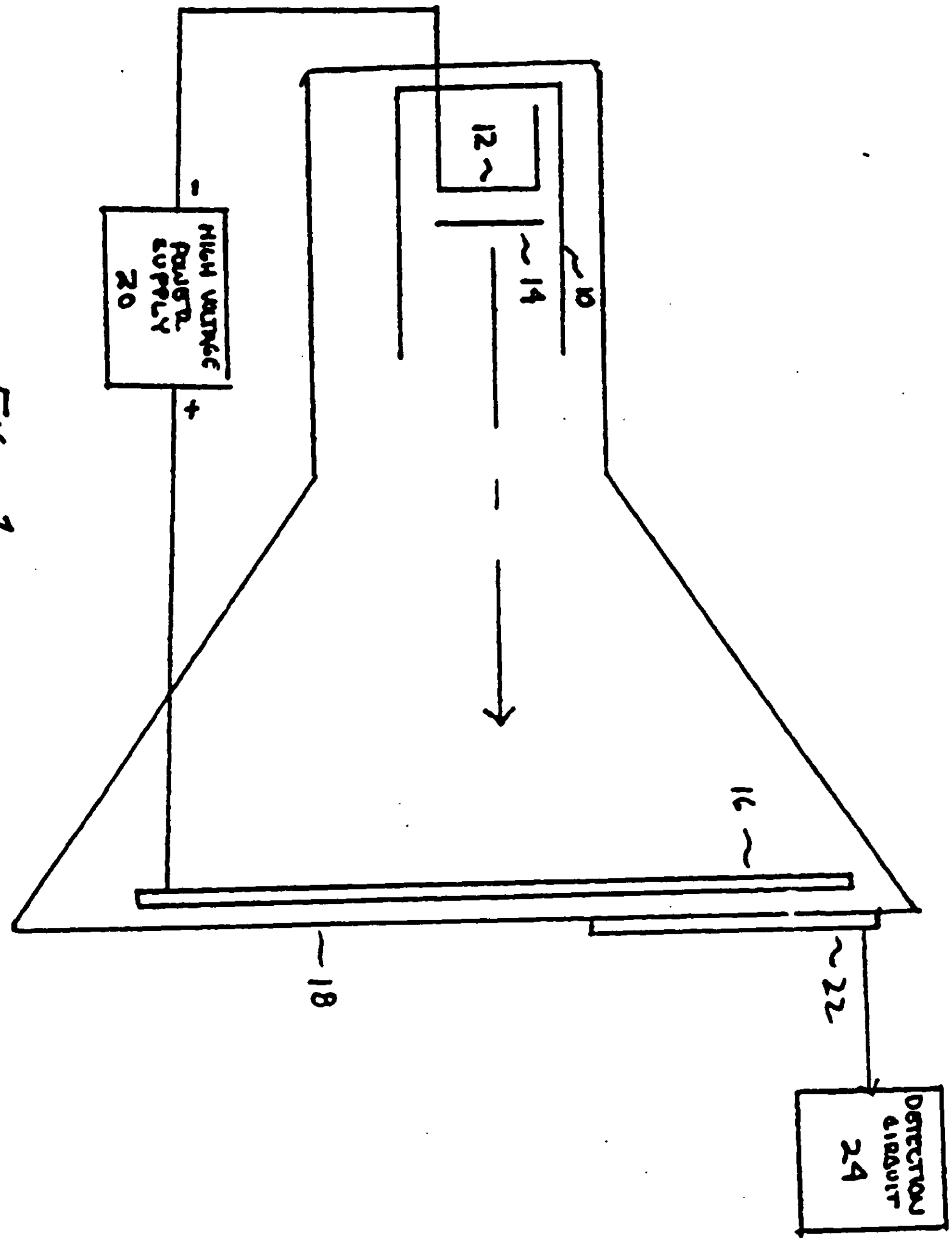

HIGH VOLTAGE POWER SUPPLY 20
DETECTION CIRCUIT 24
12
14
10
16
18
22
-
+

FIG. 1

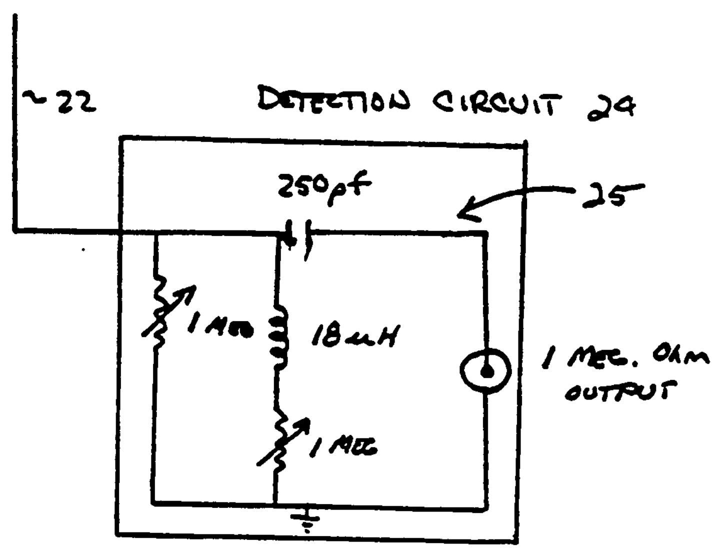

~22
DETECTION CIRCUIT 24
250pf
25
1 MEG
18 mH
1 MEG. OHM
OUTPUT
1 MEG

FIG. 2

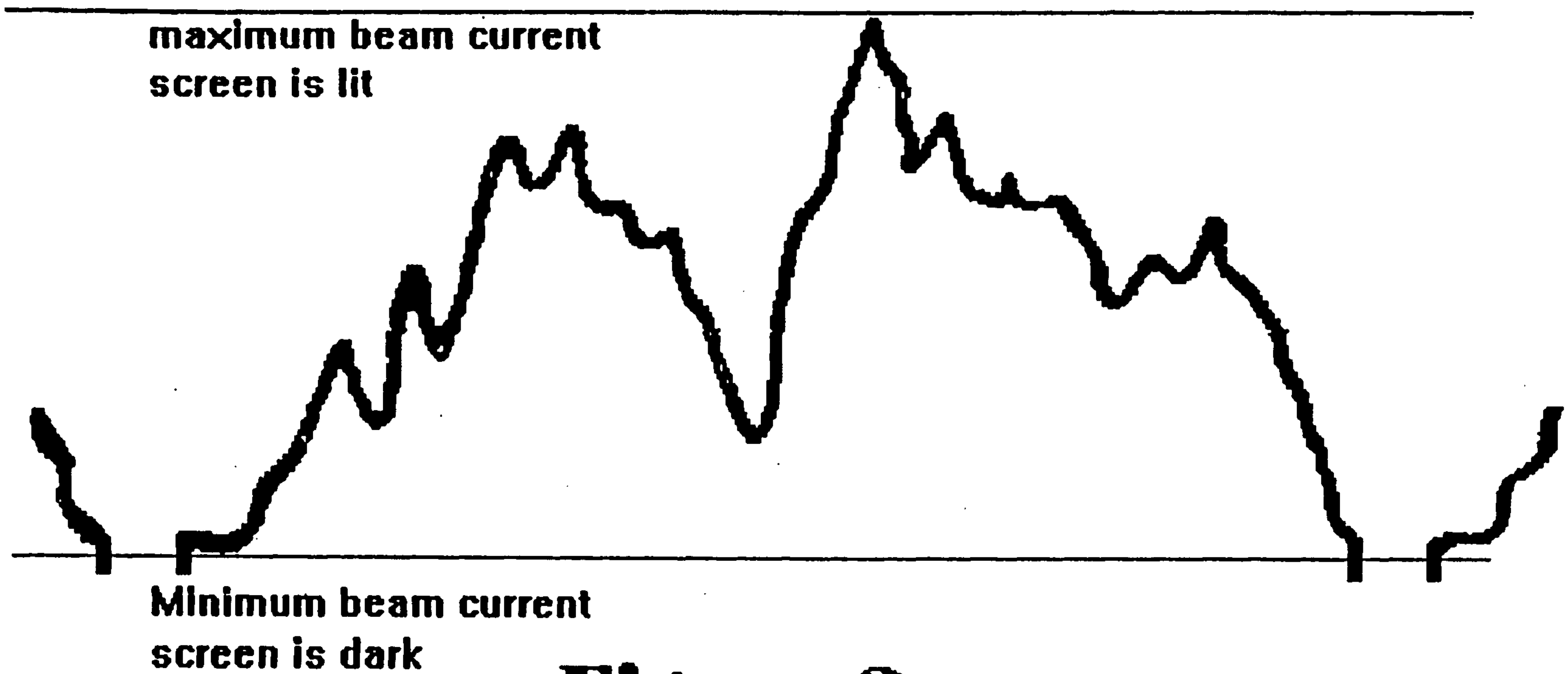

maximum beam current
screen is lit
Minimum beam current
screen is dark

Figure 3

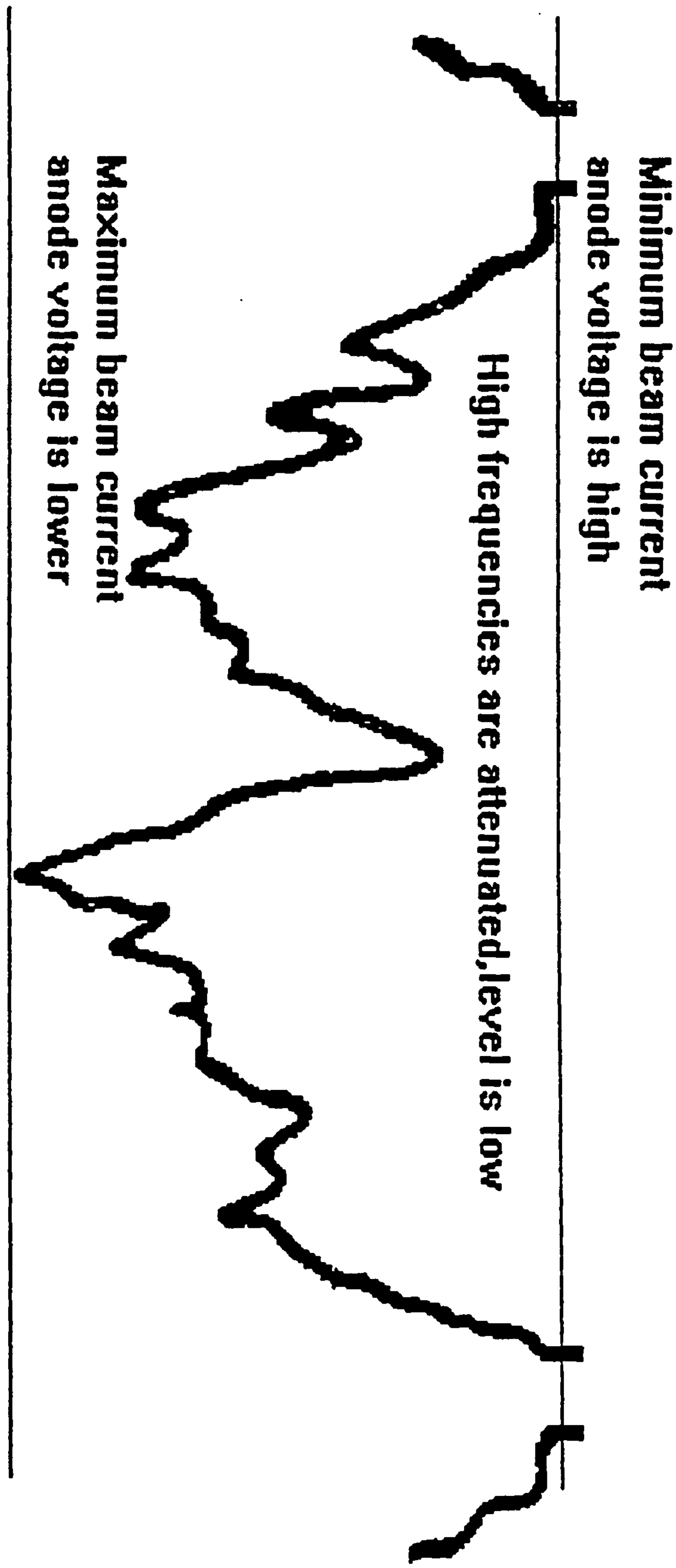
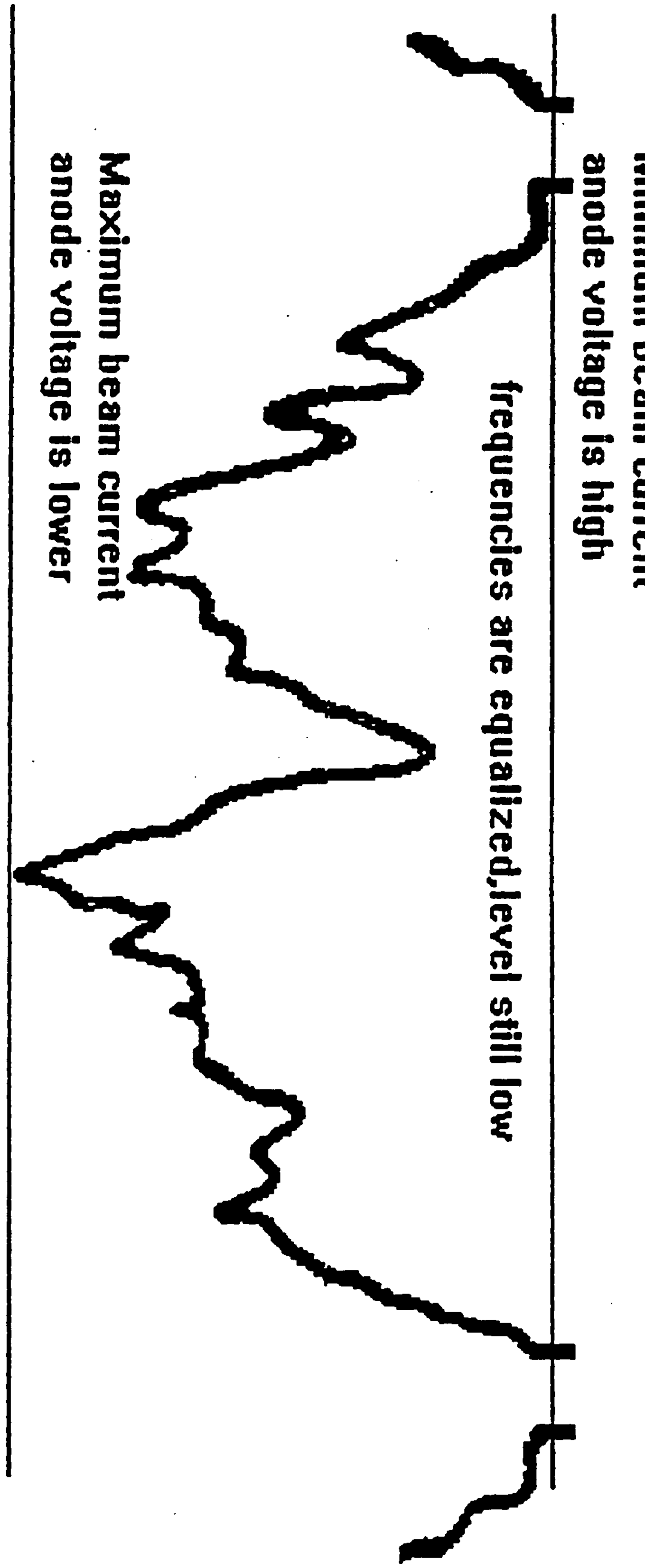

Minimum beam current
anode voltage is high
High frequencies are attenuated,level is low
Maximum beam current
anode voltage is lower

Figure 4

Figure 5


Minimum beam current
anode voltage is high
frequencies are equalized,level still low
Maximum beam current
anode voltage is lower

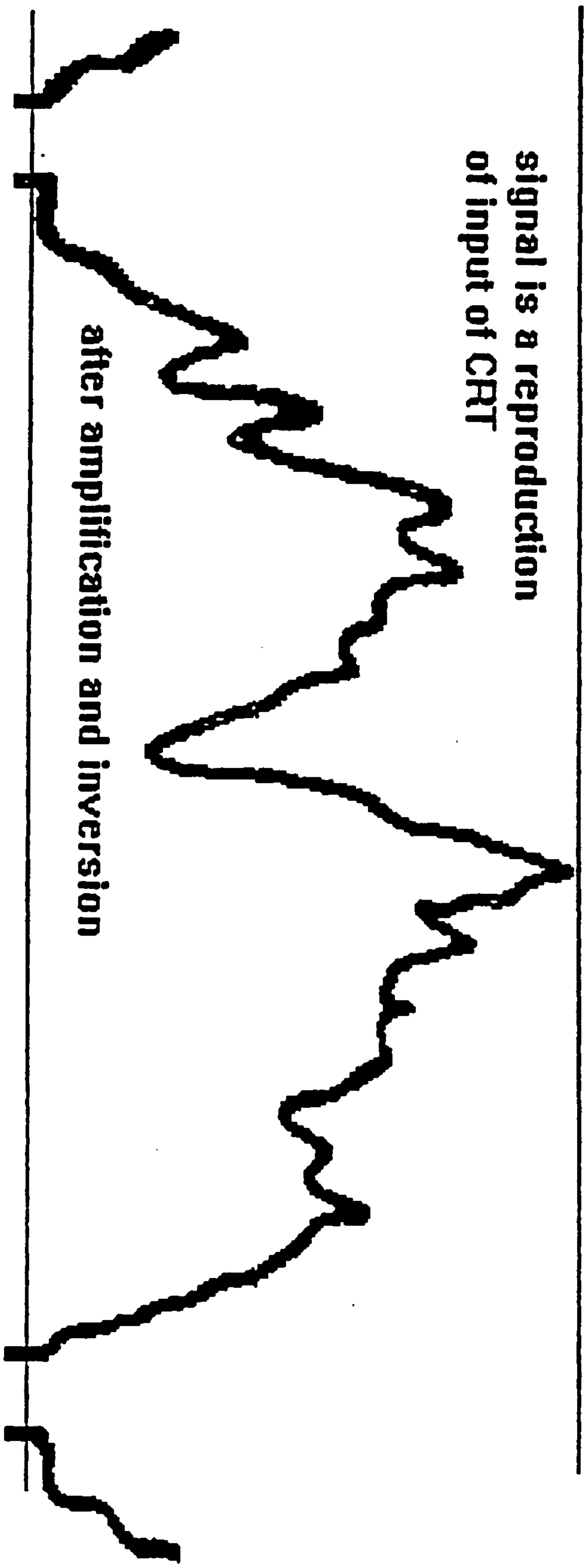

signal is a reproduction
of input of CRT
after amplification and inversion

Figure 6

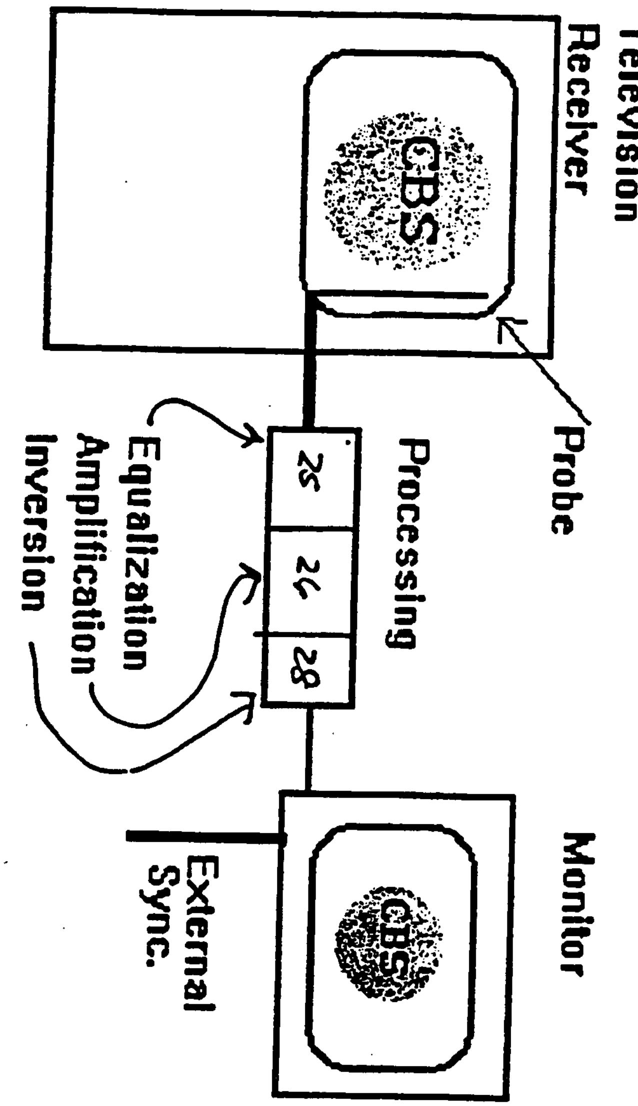

Television
Receiver
CBS
Probe
Processing
25
26
28
Equalization
Amplification
Inversion
Monitor
CBS
External
Sync.

Figure 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 42 0292

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-5 404 160 (SCHOBER GARY W ET AL) 4 April 1995 * column 2, line 58 - column 3, line 3; claim 2 * * column 4, line 21 - line 25 * * column 9, line 29 - line 51 * ---	1-8	H04N17/02 H04H9/00
A	WO-A-89 04100 (INTERACTIVE SYSTEMS) 5 May 1989 * page 4, line 32 - page 5, line 27; figure 1 * ---	1	
A	US-A-4 044 376 (PORTER JAMES L) 23 August 1977 * column 2, line 55 - column 3, line 15; figure 2 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H04N H04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 November 1996	Beaudoin, O

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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